U.S.N.										

B.M.S. College of Engineering, Bengaluru-560019

Autonomous Institute Affiliated to VTU

June 2025 Semester End Main Examinations

Programme: B.E. **Semester: IV**
Branch: Aerospace Engineering **Duration: 3 hrs.**
Course Code: 22AS4PCBAD **Max Marks: 100**
Course: Basic Aerodynamics

Instructions: 1. Answer any FIVE full questions, choosing one full question from each unit.
2. Missing data, if any, may be suitably assumed.

Important Note: Completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages. Revealing of identification, appeal to evaluator will be treated as malpractice.

		UNIT - I	*CO*	*PO*	Marks
1	a)	(i) Derive continuity equation considering finite control volume method. (ii) Consider the lifting flow over a circular cylinder with a diameter of 0.5 m. The freestream velocity is 25 m/s, and the maximum velocity on the surface of the cylinder is 75 m/s. The freestream conditions are those for a standard altitude of 3 km. Calculate the lift per unit span on the cylinder.	CO1	PO2	**10**
	b)	Show that the pressure coefficient on the surface of a circular cylinder of radius R in a uniform stream (U_∞), with a circulation Γ around the cylinder, has the form $Cp = 1 - \left(4\sin^2\theta + \frac{2\Gamma \sin\theta}{\pi R V_\infty} + \left(\frac{\Gamma}{2\pi R V_\infty} \right)^2 \right)$	CO1	PO1	**10**
		OR			
2	a)	Write short notes on following a) Vorticity and circulation and relationship between them b) What is doublet flow, derive stream function and velocity for it	CO1	PO1	**10**
	b)	(i) Derive momentum equations and deduce Euler equations with all the assumptions involved in it. (ii) Consider the lifting flow over a circular cylinder. The lift coefficient is 4π. Calculate the peak (negative) pressure coefficient.	CO1	PO2	**10**
		UNIT - II			
3	a)	Derive $C_l=2\pi\alpha$, where α is angle of attack for a symmetric airfoil using thin airfoil theory.	CO2	PO1	**10**
	b)	Consider an NACA 0012 airfoil with a chord of 0.64 m in an airstream at standard sea level conditions. The freestream velocity is 70 m/s. The lift per unit span is 1254 N/m. (i) Calculate the angle of attack assuming the thin	CO2	PO2	**10**

			airfoil theory (ii) Calculate the moment per unit span about the aerodynamic center.			
			OR			
	4	a)	Using thin airfoil theory for symmetric airfoil, show that center of pressure and aerodynamic pressure coincide with each other at one fourth of the chord.	CO2	PO1	**10**
		b)	Write short notes on Kutta condition. Show that, for a vortex sheet, 'there is a discontinuous change in the tangential component of velocity across the sheet and is equal to the local sheet strength'.	CO2	PO1	**6**
		c)	With neat sketches, describe nomenclature of an airfoil and write the characteristics of airfoil.	CO2	PO1	**4**
			UNIT - III			
	5	a)	Explain the formation of primary and secondary vortices in subsonic flow over delta wings with neat sketches. Also plot spanwise coefficient of pressure (Cp) distribution for a delta wing on both upper and lower surfaces.	CO2	PO1	**10**
		b)	Considering elliptical lift distribution given as $\Gamma(y) = \Gamma_0\sqrt{1-\left(\frac{2y}{b}\right)^2}$, where Γ_0 is maximum circulation at the origin, b is wing span and y is any location along the span Derive an expression for induced angle of attack and induced drag.	CO2	PO1	**10**
			OR			
	6	a)	Define Biot-Savart law and derive the expression for the velocity induced by (1) Infinite vortex filament (2) Semi-infinite vortex filament	CO2	PO1	**10**
		b)	Describe source panel method and vortex lattice method long with their algorithm used to their respective strengths	CO2	PO1	**10**
			UNIT - IV			
	7	a)	Consider a complex potential function given as $w(z) = U\left(z + \frac{a^2}{z}\right)$ where a is constant Calculate the following a) Velocity potential and stream function b) Velocity components c) Stagnation points d) Sketch stream lines and equi-potential lines	CO2	PO2	**10**
		b)	Under what conditions does flow over circle in z plane (z=x+iy) becomes flow over symmetric airfoil in ζ plane (ζ=ξ+iη) when **Joukowski** transformation ($f(z) = z + \frac{c^2}{z}$) is applied. Assume the radius of cylinder is r.	CO2	PO1	**10**

			OR			
	8	a)	Under what conditions does flow over circle in z plane (z=x+iy) becomes flow over ellipse in ζ plane (ζ=ξ+iη) when **Joukowski** transformation ($f(z) = z + \frac{c^2}{z}$) is applied. Assume the radius of cylinder is r.	CO2	PO1	**10**
		b)	Consider a complex potential function given as $w(z) = Uz + \frac{m}{2\Pi z}$ Calculate the following a) Velocity potential and stream function b) Velocity components c) Stagnation points d) Sketch stream lines and equi-potential lines			**10**
			UNIT - V			
	9	a)	What is boundary layer and write differences between laminar boundary layer and turbulent boundary layer.	CO3	PO1	**10**
		b)	Derive similarity solution (Blasius equation) for flow over a flat plate considering the laminar boundary layer.	CO3	PO1	**10**
			OR			
	10	a)	Explain how flow separation happens over a cylinder and indicate the favorable and unfavorable pressure gradients.	CO3	PO1	**10**
		b)	Derive an expression for displacement thickness, momentum thickness and energy thickness for a boundary layer	CO3	PO1	**10**

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